XVIII. *A Deſcription of a new Syſtem of Wires in the Focus of a Teleſcope, for obſerving the comparative Right Aſcenſions and Declinations of cœleſtial Objects; together with a Method of inveſtigating the ſame when obſerved by the Rhombus, though it happen not to be truly in an equatorial Poſition.* By the Rev. Francis Wollaſton, *LL.B. F.R.S.*

Read April 7, 1785.

IN conſequence of a paper communicated the laſt year to this Society, and honoured with a place in our Tranſactions, it may be expected of me, that I ſhould now deliver in an account of what farther obſervations I have made on that conſtellation of which I then gave a rough map. This I readily would do, if they were in any degree worthy of the Society's notice. But as yet they are far from perfect: how much better they may ſucceed hereafter, time muſt ſhew.

Yet has this year perhaps not quite been loſt; the difficulties which diſappointed my hopes, having led to what appears to me an improvement in the inſtrument with which to purſue ſuch obſervations.

My deſign, as was hinted in that Paper, was to aſcertain, as well as I was able, the right aſcenſions and declinations of the ſtars I had laid down; by obſerving their *meridian paſſages* and *meridian altitudes*, where that could be done with ſuch ſmall inſtruments as mine; as alſo by their *comparative paſſages* through the field of an equatorial teleſcope furniſhed with a

ſyſtem

ſyſtem of wires invented by Dr. BRADLEY, and called by the French *Reticule Rhomboïde*, whence it has commonly obtained in Engliſh the name of the Rhomboid.

In the former I was diſappointed by the weather; which from the time I went into the country, in the middle of May, till the end of June, when that conſtellation came to the meridian in the day-light, afforded me very few evenings fit for obſervation.

In the latter I failed, through the imperfection of my inſtrument, or my own want of ſkill in the uſe of it; for though a ſingle ſet of obſervations in any one evening would appear very good, yet when reduced by calculation, and confronted with other repeated trials, they never gave me the ſatisfaction I wiſhed.

The rhombus (for a rhombus, and not a rhomboid, it ought moſt properly to be called) is very good in theory; but very difficult to get executed with preciſion, and liable to ſome inaccuracy in the obſervation. The truth of it depends upon the longer diagonal being exactly twice the length of the ſhorter one; which requires an aukward angle (53° 7′ 48″) at the vertex, not eaſily to be hit by the workmen, and therefore ſeldom ſufficiently true. Beſide this, as the ſides of the rhombus, on which depends the calculation for differences of declination, are but 26° 33′ 54″ declining from the perpendicular or horary wire, a very ſmall error in obſerving the paſſage of a ſtar makes a very material difference in the reſult.

This determined me upon making trial of a ſquare placed angularly (an addition to M. CASSINI's wires at 45°, as may be ſeen in tab. XII. fig. 1.) which ſeems to anſwer better. I muſt confeſs I have not yet had opportunity for trying it ſo completely as I could wiſh: but I was unwilling to let this year ſlip by, without making it known; ſince, I think, from what I have done with it, I may be confident of its utility*.

The *properties* and *advantages* of ſuch a ſyſtem of wires ſcarcely need to be pointed out to aſtronomers. The whole extent of the field is employed as it is in the rhombus (the want of which was ſaid to be Dr. BRADLEY's objection to M. CASSINI's wires); but being formed of right angles or half-right angles, to which workmen are moſt accuſtomed, they will always be apt to execute their part better; and the obliques, from the differences being juſt double to what they are in the rhombus, give the comparative declinations with twice the certainty. To this the number of correſponding obſervations in the paſſage of every ſtar add conſiderably; ſince you may calculate its diſtance from the center C, from the angle D or E, or from one of the intermediate angles K, as you ſhall ſee occaſion. The ſame indeed you may do in the rhombus from D or from E; or, if the rhombus be formed of wires, from the angle at L, fig. 2.; but only with half the preciſion. The reſult of a ſingle paſſage of any one ſtar (excepting towards the extremities of the field) gives the extent of the field equally in each, provided the declination of the ſtar be known, by deducing its diſtance from thoſe ſeveral angles; and ſuch deductions ſerve as a ſtill farther check upon every obſervation; be-

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[*] What is here offered is by no means to be underſtood as recommending any ſyſtem of wires in preference to actual meaſurement with a micrometer, but to render the uſe of them as convenient as may be to ſuch gentlemen as are not provided with better inſtruments. The equatorial micrometer with a large field (ſuch as I have ſeen at Mr. AUBERT's, of Mr. SMEATON's conſtruction) I take to be the beſt inſtrument for taking differences of right aſcenſion and declination out of the meridian; and far ſuperior to any ſyſtem of fixed wires, or indeed to any equatorial ſector whatever.

cauſe, if any part of it be thought doubtful, its tallying or not tallying with the known extent of the field will ſhew whether there be any error, or where it lies. And, in each of them, the parallel wires will tell you whether the placing of your inſtrument be true or faulty; becauſe, if truly made and truly ſet, the ſame ſtar muſt take the ſame time in paſſing from one wire to its correſponding parallel; which will differ conſiderably, and in every ſtar the ſame way, if the poſition be faulty.

Some of theſe latter remarks might have been ſpared, but that they may ſerve as hints to ſuch gentlemen as may be inclined to lend their aſſiſtance to what was propoſed the laſt year, and who may not have conſidered the many helps to be derived from a croſs examination of the obſervations they make. For their uſe alſo it may be proper to add, what indeed is nothing new, that if the poſition of the inſtrument be found erroneous, the formula given by M. DE LA LANDE in his Aſtronomy will ſerve to rectify the obſervation. Calling the larger interval between the paſſage of any oblique and the horary wire m, and the ſmaller one n, $\frac{m^2n+n^2m}{m^2+n^2}$ will give the difference of declination (in time, to be converted into degrees, and multiplied by the coſine of declination) from the angle where that oblique meets the horary; and $\frac{m^2n-n^2m}{m^2+n^2}$ the difference in right aſcenſion from the ſame angle. It muſt ſurely be almoſt needleſs to mention, that where the poſition is true, *half* the interval of time between a ſtar's paſſing any two correſponding obliques, converted into degrees, and multiplied by the coſine of declination, will give the difference in declination of that ſtar from the angle where thoſe obliques meet, as the *whole* interval does in the rhombus.

But it may, perhaps, be of ſervice to aſtronomy, or at leaſt not unacceptable to thoſe gentlemen who uſe the Rhombus, that I ſhould ſubjoin another formula (contrived for me the laſt ſummer by my Son, now Mathematical Lecturer at Sidney College, Cambridge) for inveſtigating the comparative right aſcenſions and declinations of ſtars obſerved by it, when the inſtrument is not placed truly in the plane of the equator. I was led into wiſhing for ſome ſuch formula, in conſequence of an ingenious Paper, kindly communicated to me by Sir H. C. ENGLEFIELD, Bart. F. R. S. giving an account of his method of doing it by a ſcale and figure; which, though very eaſy when one is provided with ſuch a ſcale, appeared to me to be of leſs general uſe than by calculation; and I do not know that any thing of the kind is to be met with in any publication.

Let the angle DLL, fig. 2. (which, by conſtruction, is 63° 26′ 6″) be called - - - -

The diagonal LL (whoſe extent, that is, what portion of a great circle it comprehends, muſt be known to the obſerve be called - - - - -

The larger interval obſerved between the paſſage of a ſt by an oblique and the horary wire (as $b\,c$) - -

The ſmaller ditto of the ſame ſtar (as $c\,d$) - n

The larger ditto of another ſtar (as $\beta\,\gamma$) - - μ

The ſmaller ditto (as $\gamma\,\delta$) - - - ν

Then $\frac{2\,.\,\overline{m-n}}{m+n}$ = tangent of the angle which LL makes with a parallel of declination: call this q

The angle q being thus found, then

$\frac{2\,.\,\overline{n \backsim \nu} \times \text{ſin.}\ \overline{a+q}}{\text{R} \times \text{ſin.}\ a} \times \text{coſ.}\ q.$ = difference in declination between the two points on the vertical wire where

thoſe

thoſe ſtars paſs it. N. B. This being in *time* muſt be converted into *degrees*, and multiplied by coſine of declination as uſual, to give the true difference in declination between the ſtars.

And the ſame expreſſion, *viz.*

$$\frac{2\,.\,\overline{n \backsim \nu} \times \text{ſin.}\,\overline{a+q}}{R \times \text{ſin.}\,a} \times \text{ſin.}\,q =$$ the difference in Æ between thoſe two points; to be applied as a correction to the obſerved times.

The ſame may be done by the larger intervals m and μ, only by ſubſtituting $\overline{a-q}$ in the place of $\overline{a+q}$, thus:

$$\frac{2\,.\,\overline{m \backsim \mu} \times \text{ſin.}\,\overline{a-q}}{R \times \text{ſin.}\,a} \times \text{coſ.}\,q =$$ difference in declination as above;

or . . . . . $\times\,\text{ſin.}\,q =$ aſcenſional difference.

If the ſtars differ too much in declination to come within the expreſſion above (as N° 2. and 3.) then the differences of the angles D and E in declination and right aſcenſion may be found thus:

$\frac{2\,.\,b \times \text{coſ.}\,q}{R} =$ difference in declination between D and E;

$\frac{2\,.\,b \times \text{ſin.}\,q}{R} =$ their aſcenſional difference;

and the difference of each ſtar from its reſpectively neareſt angle of the rhombus, may be deduced by the former expreſſion, leaving out the conſideration of the other ſtar, thus:

$$\frac{2\,.\,n \times \text{ſin.}\,\overline{a+q}}{R \times \text{ſin.}\,a} \times \text{coſ.}\,q =$$ difference of the ſtar in declination from its neareſt angle.

and . . . $\times\,\text{ſin.}\,q =$ its difference in right aſcenſion.

The application of theſe formulæ is very eaſy: for having ound q, if you ſet down its coſine in one column for declination.

tion, and its ſine in another column for right aſcenſion, and under each the conſtant ſin. $\overline{a+q}$, and the arithmetical compl. of ſin. a; theſe being added together will make two ſums, for the comparative obſervations of every ſtar which may paſs your field; and, unleſs your field be very large, and the declination of the ſtars very great, if to the column for declination you add the coſine of declination of the center of your field, it will adapt itſelf to all the products.

FRANCIS WOLLASTON.

Charter-houſe-Square,
March 15, 1785.

POSTSCRIPT.

SINCE the delivery of this Paper, it has occurred to me, that it may ſometimes be convenient to know the angle of deviation from the true equatorial poſition in the new ſyſtem of wires. This is to be deduced nearly in the ſame manner as in the rhombus; for $\frac{m-n}{m+n}$ = tang. q. By this angle any obſerved differences in right aſcenſion may be corrected: for the difference in declination between any two ſtars (or their difference from the angle) multiplied by ſin. q, will give the correction required.

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Fig. 1.

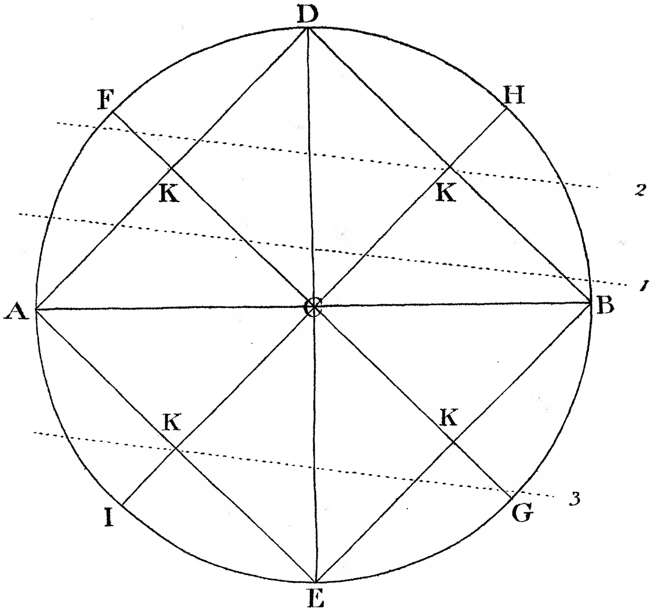

Fig. 2.